

a greater rate than 1° in 185 feet, then our ascending mass will, at its new altitude, find itself warmer than the surrounding air, and its buoyancy will cause it to rise still farther, and in fact, indefinitely, unless the temperature of the quiescent layers of air diminishes slowly enough to bring them back to the temperature of the ascending mass.

The rate at which an ascending mass will cool, viz, 1° in 185 feet, is called the adiabatic rate, which means that it cools, not by virtue of any abstraction or loss of heat, but by the conversion of its heat into some other form of energy.

THE PREDICTION OF TORNADOES AND THUNDERSTORMS.

In connection with the destructive tornadoes that passed over Missouri and Iowa on April 27, the Chicago Tribune says:

Nothing could have saved Kirksville, for the cloud evidently gathered near it, and was upon it before any one was aware; but might it not have been possible to warn Newtown, the next place in its course, so that its inhabitants could have taken every precaution to save themselves. Nothing would be of any avail in the immediate locality where the tornado has its beginning, but is it not possible, in these days of telephones and telegraphs, to send a warning to others in its course?

It is certain that if any such arrangement were possible, the Weather Bureau would have done this many years ago, but the time has not yet come. Already, in 1871, we began making general predictions in the well-known phrase "severe local storms are probable for the region," etc. We knew just as well then as now, that tornadoes occur on the south and east sides, and within the neighborhood of cyclonic vortices. General experience, as summed up in Finley's researches, has shown that tornadoes always whirl in the same direction, and generally advance at the rate of about 20 or 30 miles per hour for many miles toward the southeast, east, or northeast; that furthermore, if an observer sees one approaching him, his best method to escape its violence is to go into some cellar, cave, or trench, or failing in this, to go rapidly southward, as the chances are usually in favor of the storm going toward the northeast. Keep out in an open region and get down as low as possible. These are the only local precautions that can be taken to save one's life.

The great difficulties in the way of sending a warning forward to the next town are three:

First. You do not know exactly which way the tornado will move as a whole, and you may warn the wrong town; the present storm is said to have moved at first toward the northwest and then to the southeast.

Second. The tornado frequently retires to the clouds and is no longer felt on the earth.

Third. Every one, even the telegraph operator, is busy looking after his own safety, and when the word comes, "look out for the tornado," scarcely any one has the self-sacrifice or the self-possession requisite to call up "central," and spend several minutes in sending off the necessary dispatch to the next town. Once or twice it has happened that the telegraph operator has sent the word "tornado" on to the next station, but this can not be expected to happen, as a rule, in ordinary small country telegraph and telephone offices. We grant that it might be possible for the telegraph and telephone companies to organize a valuable system among their operators, by dint of a great deal of drill and a penalty for every failure. Such a system would be equally valuable when applied to severe thunderstorms, cold waves, prairie fires, earthquakes, meteors, and other phenomena that move over the surface of the earth. Some years ago, Prof. S. F. Baird attempted some arrangement of this kind with regard to the appearance of shoals of fishes, for the

benefit of our fisheries. It is said that when the Morse telegraph was first built between Washington and Baltimore, it was quite common for the operators along the line to herald the approach of thunderstorms; subsequently, the progress of the floods down the Ohio, and of the breaking up of ice in the Mississippi were also similarly telegraphed by operators to river men.

But river floods and cold waves are simple matters compared with the instruction drill, watchfulness, and skill that would be requisite if the telegraph and telephone companies were to undertake anything like a satisfactory plan of tornado prediction from town to town.

Fourth. The principal difficulty consists in the fact that the telegraph and telephone stations are so far apart that three-fourths of the thunderstorms, to say nothing of the tornadoes, that are liable to pass over the central station, slip in between the outlying stations and, therefore, strike a town without being announced. It seems almost incredible, until we actually study the map, that there are so many gaps in the network of stations surrounding our principal cities, as to prevent our undertaking a satisfactory system of local thunderstorm predictions. We may illustrate this by our own experience in thunderstorm predictions for Washington. An elaborate map was prepared by the Editor in 1897 as a preliminary step toward the collection of thunderstorm data, and the organization of a system of daily thunderstorm predictions for the Capital. Every telegraph and telephone station within a hundred miles north, south, and west, was plotted down, and it was quickly found that thunderstorms whose average diameter is 5 miles would, inevitably slip through when approaching from the northwest, and could rarely be detected when approaching from the west or the north, the southwest or the south, in time to allow of any satisfactory prediction. Stations must be within a mile of each other in all directions in order to catch every tornado and determine the direction of its path in time to frame a warning that could be of any use to a central city. We have no right to issue numerous erroneous alarms. The stoppage of business and the unnecessary fright would in its summation during a year be worse than the storms themselves, so few and so small are they. However, as stated before in the MONTHLY WEATHER REVIEW, serious efforts in this direction should be made, and the local studies should be at once begun for the larger cities, such as St. Louis, Chicago, Cincinnati, Detroit, Buffalo, New York, Boston, Philadelphia, Baltimore, Washington, and New Orleans, since all these cities are surrounded by lines that are kept in good condition, and have so much at stake. At the outset, our efforts must be imperfect, but they will improve with experience. In general, we must remember that the destructive areas of tornadoes, and even of thunderstorms, are so small that the chance of being injured is exceedingly slight. For a tornado it is scarcely 1 per cent per century, that is to say, there is a certainty of being injured once in ten thousand years. This small chance renders it difficult to say how much could profitably be expended in order to avert disaster. If we grant that the chance of occurrence is exceedingly small, and the certainty of destruction is absolute when the tornado comes, then it follows inevitably that there is no material advantage to be derived from any, even the most perfect, system of forewarnings and attempts at protection. In ordinary life, we do not attempt to prevent that which is inevitable, but by a system of mutual insurance, divide up among many the loss experienced by one individual. Just so in the case of the tornado, so long as we can not possibly avoid it when it comes, the most perfect system of prediction will be of no avail, and the only method of alleviation is to be found in some method of insurance.

Inasmuch as we know that droughts and floods, storms and frosts, always have occurred in any given locality, therefore,

when we cultivate the land and plant our crops, we do so in full knowledge of the impending chances of disaster. On the one hand we have no right to expect uninterrupted immunity and prosperity, nor on the other hand when disaster comes have we any right to be discouraged and say that the land or the crop, or we ourselves personally, are accursed. Never in the history of the world has it ever been possible for any one to carry out to successful completion his schemes and plans without an intense struggle against all forms of opposition, and in this struggle, it is not so much the strongest will as it is the highest intellect that succeeds.

INTERNATIONAL COURTESY.

Several times in the history of the Weather Bureau, both under the Secretary of War and the Secretary of Agriculture, it has happened that the Bureau has found it necessary to adopt certain rules appropriate to the courteous intercourse of nations as equals. Such rules may sometimes have seemed to make science subordinate and national honor supreme. This is as it should be, although we occasionally find an unreasonable independent thinker who will not willingly submit to this or any other form of subordination.

We see no reason why science and scientists should not be amenable to the common law, to international law, and to the laws of international and individual courtesy—laws which are oftentimes not formulated but are fully recognized by all fair-minded people, juries, and judges, and which are nearly all summed up in the golden rule: "Do unto others as you would have them do unto you."

In the early history of the Weather Bureau it was clearly recognized by that most cautious diplomat, General Myer, that although his authority was absolute within the United States and under the limitation of the laws of Congress, yet it did not extend one foot beyond the seven league limit of our Atlantic and Pacific coasts, and was bounded sharply by our Mexican and Canadian boundaries. By a most courteous and generous arrangement, he secured from the Canadian Government the daily observations that he needed and gave to the Chief of the Dominion Service such observations, predictions, and warnings as would strengthen his service. Later, when he needed observations from distant oceans and countries in order to trace the complete history of our storms, he invited each nation to cooperate with him on the same basis as in the case of Canada, and every one responded most heartily. In order to strengthen this union of all nations in one great work, he subsequently presented a general request to the International Meteorological Congress of 1873 at Vienna and secured a strong vote in its favor.

In the same year, in order that our own hurricanes might be better forecast, he asked permission of the governments having colonies in the West Indies to establish Weather Bureau stations with the privilege of using his meteorological cipher system in making daily reports. In some cases this was declined, in other cases it was allowed; but in every case there was no question as to the necessity of treating each nation, large or small, with the same courtesy. About 1878, when a private party in New York gave great offence to the British Meteorological Office, great scandal to practical meteorology, and great annoyance to the British public by frequent publication in England of storms about to arrive from America, General Myer was obliged to explain that he, personally, had no authority in this matter. He could, of course, prevent the publication of unauthorized weather predictions within the United States, but could not prevent their publication in Great Britain. However, realizing that we might, as individuals, privately assist our colleagues in their dilemma, the Editor made a quite careful examina-

tion of every prediction that had been published in this unofficial manner in England, and his report, showing but 17 per cent of real verifications and about 25 per cent of partial verifications, was so widely distributed in England and so convincing that it soon became undesirable for the enterprising Anglo-American newspaper to continue such work. The intruder was defeated on his own ground and the rules of international courtesy were fully complied with. Afterwards, a daily telegram was sent from the Chief of the Weather Bureau at Washington to the Director at Paris, advising him of the condition of the atmosphere on this side of the Atlantic; and this still continues. This is simply advice to him, not a prediction for publication to the people of France. The new West Indian branch of the Weather Bureau service preserves precisely the same international comity. The respective observers inform the local insular colonies of the approach of a hurricane only when local governments desire this to be done. No act is allowed that could in any way be interpreted as an effort or willingness on our part to override local rights and the authority of the sometimes long-established local meteorological officials.

The questions that have lately excited so much public attention in reference to the relation between the meteorological observatory at Manila and the forecasts for China and Japan could easily be settled by adopting the same international courtesy that has distinguished the policy of the Weather Bureau. It would seem that, although the Spanish Government has relinquished national rights in the Philippines, yet the Jesuits at the Manila Observatory are loth to surrender their old-time privileges. Through the indulgence of the British and other colonial offices, they have for several years conducted a voluntary storm-warning system for both the Philippines and the adjacent coasts of Asia. The French, German, English, Spanish, and native authorities stood in such complex relations to each other that out of pure courtesy and conservatism, and because nobody else offered to do the work, they all allowed the voluntary work of the Manila Observatory to go on from year to year. The question now arises, whether our temporary military government in the Philippines should, or should not, respond favorably to the request of the English officials at Hongkong, to the effect that the warnings from Manila be confined to the Philippines. If the meteorologists at Manila have anything to communicate relative to storms approaching China, Japan, or colonial stations, such as Hongkong, why can not the communication be sent, as a matter of international courtesy, to the meteorological offices of those places? Why should not the latter bear the responsibility of giving proper local warnings? Why should local papers and harbor masters circulate warnings from irresponsible parties?

When we consider the uncertainty of even the best storm predictions, one must wonder that the Manila meteorologists are willing to risk their reputation by such long-range work, several days ahead, and for places a thousand miles away. We are not surprised at Dr. Doberck's complaint of the inaccuracy of the predictions and the harm that they do the public. Admiral Dewey testifies that the work at Manila has been very satisfactory, so far as he can judge from his experience in the Philippines, but he says nothing about the China coast. The publications of the Manila Observatory show a laudable energy in the study of typhoons, although based on rather scanty data. The present question is not as to the study of storms, or the ability to predict them, but as to the right of issuing public predictions that may in any way bear the stamp of official authority, as emanating from, or allowed by, or even feebly recognized by, the Government of the United States. On this point there can be no doubt. The Philippines are now, by treaty, recognized by all the world as a portion of the territory of the United States.